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It is proposed to publish from time to time, as occasion may serve, Bulletins on subjects connected with Agriculture and Horticulture in the Malay Peninsula. It is hoped that planters will send to the Director of the Botanic Gardens, Singapore, notes and observations on the cultivations of the various crops under their care. Observations on insect and fungus-pests are especially requested, and these should always be accompanied by specimens of the injurious insect or fungi either alive, or preserved in spirits, except in the case of butterflies and moths, which should be sent dry in envelopes.

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GAMBIR.

Introduction.

Of all the vegetable products of the Malay Peninsula, gambir takes the second place only in importance. In the tanning and silk trades it is well known to be indispensable, and it is also used to a small extent in medicine. The larger portion of the drug which finds its way into the market is exported from Singapore, and the average value of the annual export for the last five years is $4,682,333.

The import into the British Islands in 1889 was, roughly speaking, of the value of £460,000, and the United States took in the same year nearly £180,000 worth. Nevertheless hitherto this important cultivation has been in the hands of the Chinese and Malays only. Europeans as yet have hardly begun to think seriously of undertaking it, and yet it is certain that a properly treated estate would bring a good profit. The reason of this neglect is, it seems, that the Malay Peninsula with the adjoining islands of Rh[illegible], Lingga, Banka and some others, where alone the plant seems to thrive, has not yet come under the hands of the European planter to any large extent, and the few planters who have settled down in the Straits Settlements and Malay Peninsula have devoted themselves almost exclusively to coffee and tea cultivation.

There are signs, however, of an increasing interest in planting, and the attention of the planter is turning to other products than these, and among them to gambir, and indeed there is no reason why this plant should not be grown on a large scale. In the Malay Peninsula there is plenty of suitable land, the cultivation is easy and not expensive, the plant is quick-growing and will bring a return within a year or a year and-a-half after sowing, and the demand for the product is steady and constant.

It is true that, on the whole, the price of gambir has fallen in the last few years, but this is due entirely, I believe, to deterioration of the quality. The Native, working with rough apparatus and being very careless as to result, supplies the market with an inferior article unnecessarily loaded with water, often containing as much as from 30 to 50 per cent. In the hands of Europeans, with the aid of better methods of cultivation, and of improved machinery, a much superior class of gambir might easily be produced, while at the same time by doing away with the middleman, represented here by the Chinese *towkay*, the expenses of the product would be lessened.

Nor is the interest in the gambir cultivation confined to the Straits planter. Requests for seed and young plants have been addressed to the Botanic Gardens at Singapore from all parts of the world. To Borneo, India, Australia, Africa, the West Indies and other tropical colonies of the Empire, seed has been sent in quantity. In some of these countries it is probable that the gambir will not thrive well enough to bring profit by its cultivation, owing to the difference in climate, but this is impossible to decide till the experiment has been tried.

Comparatively little has been written on its cultivation and manufacture, and much of that that has been published is inaccurate and misleading. I have, therefore, besides consulting all accessible works referring to the subject, visited plantations in different parts of the Straits Settlements, cultivated the plant myself, and, with the aid of Dr. Bott, Government Analyst, made some experiments in improved methods of preparation. The information thus obtained I have set forth in order, so that this article may be as full as possible and may perhaps be of use to intending planters.

Description of the Plant.

The Gambir plant (*Uncaria Gambir*, Roxb.) is a climbing shrub, clambering over trees and bushes to a considerable height by the aid of its recurved hooks. The stems are from one to three inches in diameter in the cultivated plant, but usually slenderer when the plant is allowed to climb as in a wild or half wild state. The branches are slender, smooth, quadrangular and rather stiff, with a thin, reddish bark.

The leaves are opposite and arranged in one plane, in shape ovate acute sometimes acuminate about four inches in length and two in diameter with short stout petioles a quarter of an inch long. They are dark green, and shining above, paler beneath, with the midrib and five lateral veins on each side prominent. The old leaves are stiff and firm in texture and possess a strong astringent taste. The stipules are light green, ovate lanceolate, blunt, three-eighths of an inch in length.

The flowers are very numerous, in compact balls about an inch and-a-half through, on straight, stiff peduncles about one and-a-half inches long. These peduncles, which arise from a point a little above the pairs of leaves, are often converted into hooks. The flowers are about half-an-inch in length, sweet-scented in the evening.

The calyx is shortly tubular with five small lanceate obtuse sepals not appressed to the corolla tube but rather spreading, pale-green with darker points. The corolla is tubular half-an-inch long, slender, gradually increasing in size upwards, green or pale red, ending in a limb of five small lorate, blunt, spreading lobes, one-eighth of an inch long.

The stamens are five in number, alternating with the corolla lobes, the anthers sessile at the mouth of the tube, linear. The style is long and slender, projecting a quarter of an inch beyond the corolla mouth, ending in an entire club-shaped stigma.

After flowering the pedicels of the flowers, previously very short, lengthen, and in the fruit are half-an-inch long. The fruit is a narrow fusiform capsule three-quarters of an inch long crowned with the calyx lobes. It splits on one or both sides longitudinally in the middle for the greater part of its length, and lets fall the exceedingly minute seeds, which are very copious. The seeds are thin and flat with an oblong papery wing at each end.

The flowers, which last but a short time, are visited by the small bees known as *kelulut* (*Trigonia sp.*) in the search for pollen. As they creep over the flowers while gathering it, they do not fail to rub the abdomen sprinkled with pollen over the far projecting

stigmas and so fertilize the flowers. Far the greater number of flowers are fertilized and set fruits. The seeds, which are very light, are drifted to suitable spots by the wind.

There are about twenty species of *Uncaria* to be met with in the Malay Peninsula; but *U. gambir* is the only one which has been used to obtain the drug. It is possible that some of the allied species, however, might produce a certain amount. The *Uncarias* are usually found on the borders of jungle, climbing over the trees. Some, like *U. sclerophylla* and *U. pedicellata*, attain an enormous size, forming huge lianes, and are met with in the high jungle. One or two of these are water vines producing when cut a good supply of excellent water. *U. gambir* and the allied species are much more slender plants. I have rarely seen the plant in such a position that I could say that it was really wild. It remains on old cultivated ground long after that has reverted to jungle, and in these cases often looks different from the plant as seen in cultivation, being more slender, and narrower in the leaf. There can be little doubt, I think, that the plant is a native of the Malay Peninsula, and will probably be found in a really wild state sooner or later.

There seems to be some idea current that a plant described by Hunter under the name of *Nauclea acida* (*Uncaria acida*, Roxb.) is also cultivated for the production of gambir. What Hunter intended by this plant, it is impossible now to guess. His description is too meagre, and none of his specimens are extant. He found it in Penang, but he does not say in his paper that it produced gambir at all, or was used for that purpose.

History of the Plant and Drug.

I have been unable to find any earlier reference to gambir than that of Rumphius (*Herbarium Amboinense*, v. 63, t. 34) in 1750.* There is no mention of it in Garcia's *Historia Aromatum*, nor in Pomet's *Histoire des Drogues* (1694), nor even in Steven's *Compleat Guide to the East Indies* (1766), although in that book the prices of goods at Malacca are given. Rumphius describes three species of *Uncaria*, under the name of *Daun Gatta Gambir*, but his figures and descriptions are so bad that it is impossible to tell what the species were he had in view. Probably, however, the plant he called *Funis uncatus latifolius* was *Uncaria gambir*. This plant, he says, was very common in open country in Amboina, Celebes, Bali and Sumatra near Palembang. It was called *Daun Gatta (* and *Gitta) Gambir*, because its leaves had a taste of the lozenges called Gatta Gambir, although these were obtained from a different plant. The Malays chewed the leaves with the betel (but did not at that time make the extract), and also cultivated it for the scent of its flowers. The Amboinese, however, used the juice for healing ulcers. The plant was thus first cultivated for its flowers and for the leaves as a masticatory.

The original Gatta Gambir referred to in Rumphius as being

* Colonel Yule in "Hobson Jobson," however, quotes Debry for an earlier reference. This book I have not seen.

used in the form of lozenges was probably the product of *Acacia catechu*, which was imported into Malacca from Cambay as early as 1514 (Barbosa in Hakluyt's Voyages, 1866, p. 191) for use as a masticatory.

The Tamil name of this Catechu is *Kate*, which is spelt in Garcia's *Historia Aromatum* (Lib. I, 43.) Cate, and the variant Cato is said to have been the name of the drug in Malacca. Couperus (1780) gives Catjoe as the Dutch name in Malacca in his time, and of course Cachou and other similar names are mere variants of this.

Before 1750 the Malays discovered the use of gambir in place of cutch, which was too expensive for the poorer classes (Couperus, l.c.). It was probably at first called Katta Krambu, *i. e.*, scented cutch, and the Tamils to this day in Singapore call it *Katta Krambu*, or *Kambu*. Much of the chewing gambir came at that time and still comes from Siak in Sumatra where it is made up with cloves, hence the product was called scented cutch to distinguish it from the *Acacia catechu*, common cutch. This name Katta Krambu was altered by the Malays into *Gatta Gambir*, and later into *Getah Gambir*, often incorrectly spelt Gambier by Europeans. The word Getah is not applied by the Malays to an extract made by boiling, but signifies a viscid milky liquid like that of *Dichopsis gutta* (Getah Percha).*

The earliest account of the cultivation of gambir in the Malay Peninsula was published by Abrahamus Couperus in the *Verhandelingen van het Bataavisch Genootschap* (1823, II, pp. 209-226). The paper is dated 1780. He says that the seed was first brought from Pontjan (Puntian in Johor) in 1758, and failed to germinate at Malacca. Young plants were then obtained, and proved so successful that many plantations were soon established. Chewing gambir only was produced, but in such large quantities that in 1780 gambir that produced from 26 to 28 *ryksdalers* a pikul fell to 6 *dalers*, and plantations which formerly fetched 800 *ryksdalers* sold for 60. I am indebted to Mr. J. Fleury, the Netherlands Vice-Consul, for a translation from the Dutch of Couperus' very interesting paper.

The next account is that of William Hunter (Trans., Linn. Soc., IX, p. 218, read in 1807). He describes the cultivation in Penang, by Chinese and Malays. It was still only used for chewing and for medicine, but the cultivation seems to have revived a little by this time. Siak in Sumatra produced a large quantity for export, as it did in Couperus' time and still does. Good gambir now fetched 8¾ dollars a pikul. About 1820 it began to be exported to China and Java as a tanning and dyeing material (Crawfurd, *Dict.*, *E. Indian Islands*, Vol. iii, p. 415). It then fetched no more than 3 to 4 dollars a pikul in the Peninsula, and double that price in Java.

In 1819 the cultivation was introduced into Singapore, but so much was shipped from the adjoining islands, and the necessary

* Rumphius gives, however, another derivation, viz., from a word *Gambir*, which signifies a Jasminum, and says that the plant was so called on account of its being scented like jasmine, but this word is not used for the wild jasmine in the Peninsula, as far as I know, though Favre gives *Bunga Gambir* as the name of "Jasminum grandiflorum." I am more inclined to think the Jasmine in this case takes its name from the Gambir and not *vice versâ*. Some of the wild Gambirs are called *Akar Kayet Kayet*, which is perhaps the same word as Cate.

supply of fuel diminished so rapidly from the destruction of the forests, that the cultivation began to decline rapidly. The first shipments to Europe from Singapore took place in 1830, when 3,234 cwts. were exported. In 1834 the export had fallen to 2,322 cwts.

Since that time the demand and exports have enormously increased, and in 1890, 769,704 pikuls, equalling 4,567 tons, were exported from Singapore alone. The greater part of this comes from the Dutch islands, especially Rhio, Lingga, Bintang, Carimons, and a little from Sarawak. Bangka gambir is apparently not imported into the Singapore market, or if it comes in, it does so *viâ* Rhio, as Rhio gambir.

In the Malay Peninsula the cultivation is by no means as extensive as might have been expected. In Singapore there are still a number of plantations, all small, but the great extent of country now covered with lalang-grass shows how extensive the former cultivation was and how it has fallen off. Johor and Muar produce a large quantity, the best of which is obtained at Batu Pahat on the West Coast.

In Negri Sembilan are a few small plantations, where chewing gambir only is made. In Malacca there are two or three large plantations carefully cultivated by the Chinese, where export gambir is made, and some smaller Malay ones where a good deal of chewing gambir is produced. Perak, Penang, Province Wellesley and the East Coast States produce little or none. In Pahang some way up the river Tembeling is a small amount of cultivation for local consumption, which appears to have been going on for many years.

Uses of the Drug.

Gambir is, as stated above, one of the most important tanning materials. Mr. Evans informs me that it gives a peculiar gloss to the leather not produced by other tanning substances. It holds the second place in importance, oak bark being naturally the most important. Sumach (*Rhus coriaria*), an European shrub, is almost of equal importance with gambir, and is produced in large quantities in Southern Europe.

It is also used as a brown dye and for strengthening canvas and making it waterproof, and a very large quantity is used in the silk works.

For these purposes, the greater part of the gambir exported from Singapore is sent to Europe and the United States. The amount exported has not fluctuated much of late years. Since 1886, the smallest yearly export was 672,183 pikuls in 1888, and the highest 769,784 in 1890.

Of this, the largest quantity goes to the British Islands, which took 2,789,975 dollars' worth in 1890—a distinct increase on former years. Germany and France since 1886 have both doubled their import, the former from 366,852 dollars' worth in 1886 to 677,554 in 1890, the latter from 397,752 to 797,443.

Italy, which takes a comparatively small amount, has fluctuated very much. The highest value it recived during that period was 93,411 dollars' worth.

The United States have increased their demand since 1886 from 783,404 to 1,197,403.

British India's demand has increased from 79,627 in 1886 to 132,655 in 1890.

The Dutch Indies take also an increasing quantity, viz., from 530,000 to 778,170.

In Austria, however, the import has fallen very considerably, viz., from 59,152 to 1,050 dollars' worth. This is probably due to the larger use of Sumach, which is abundant in this country.

The price of gambir has fallen very considerably of late. The reason for this is not over-production, for it appears that the amount produced is not much in excess of former years, but is due to decreased consumption, from depression in the silktrade.

The following table gives the exports of gambir from Singapore from 1886 to 1890, from the Straits Settlements *Gazette* of May 29th, 1891:—

1886,	... 673,718	pikuls.
1887,	... 732,962	,,
1888,	... 672,183	,,
1889,	... 720,931	,,
1890,	... 769,704	,,

This shows that there is, on the whole, a little increase in its cultivation.

Besides its use as a tanning material and a dye, gambir is used, to a small extent, in medicine under the name of *Pale catechu* as an astringent. It is efficacious in chronic diarrhœa and dysentery, and is thus used by the Malays, and also for uterine hæmorrhage and general mucous discharges, for bleeding of the nose, in the form of an ointment for ulcers, and in other cases where an astringent is required, and it is especially valuable for relaxed uvula and hoarseness. It is more powerful in its action than the catechu of *Acacia catechu*. Dr. Trimen in *Medical Botany* states that it is more commonly used in medicine in India and England than in America.

As a masticatory in place of areca-nut, it is very extensively used throughout the East, and is sold in all the small shops in the country. The chewing gambir is made chiefly by the Malays, but a large quantity is imported from Siak in Sumatra. The Siak manufacturers mix cloves and other ingredients with it, to improve the flavour, but the Malacca Malays make it quite pure.

Another use for gambir has been suggested by Mr. T. C. Drysdale in *Logan's Journal*, 1850, Vol. v, 162, namely, as a preservative of timber in sea water. He states that in 1848 the vessel *Ocean Queen*, while on a voyage from Singapore to London, was a wrecked on the North-East coast of Linggin, and sank in nine fathoms of water. Four months after it was found that the whole upper decks were "riddled with barnacles" (probably *Teredo* is intended). There was a quantity of gambir in the hold, and when it was broken into the water all round the ship was saturated with gambir, whereupon all the "barnacles" died, and had not reappeared eight months afterwards. Acting upon this, a Mr. Clunis tested the effects of gambir by painting the bottom

of a boat with a composition of dammar oil, gambir and chunam, and observed that the mixture appeared to preserve the boat from barnacles and algæ for a considerable period. Attempts have also been made to use it as a preservative of timber against termites, and it seems to have some effect at first, but being soluble in water it appears to lose its efficacy soon, and furthermore as in all other liquid wood preservatives, it is useless to merely paint the outside of the timber as the termites attack the interior, and no method has yet been found by which the wood itself can be impregnated thoroughly with it.

Forms of Gambir.

The Malays make four kinds of gambirs, viz. :—*Gambir papan, bulat, paku* and *dudur*.

The first two of these are chewing gambirs, the others are used for dyeing.

Gambir bulat (round gambir) is the most expensive of the chewing gambirs. The Siak gambir is usually of this form, but is much adulterated with rice dust and cloves. It consists of thin circular biscuits about 1½ inch across and about a line thick and in valued at 9 or 10 dollars per pikul.

Gambir papan (lit. board gambir) is in the form of thin squares about an inch and-a-half each way, and about one line thick. It is light brown, paler within, and rather crumbly in texture. It is valued at $5.50 to $6 per pikul. This is the form known in the Singapore trade as Flake Gambir.

Gambir paku (nail gambir) called in trade Finger Gambir is made in the form of sticks, about three inches long. It is rather a sticky viscid material, and very dark in colour. Its highest value is $6 a pikul.

Gambir dudur (dice or cube gambir) is made in small cubes an inch each way. There are two forms—No. 1 is of a light reddish brown outside, and a light yellowish brown on fracture, very homogeneous and fine grained, dry and easily powdered. It is valued at $9 a pikul; No. 2 is darker, blackish brown, less homogeneous and shiny. It is of inferior quality and is valued at $7 a pikul.

Van Romburgh also mentions a form manufactured for the inland market in West Java in round pieces, 24 mm. by 9 mm., which commands a higher price than the square flat cakes.

Some other forms are mentioned by Couperus as used in his time. The best quality, he says, has a triangular shape, each side having a length of about one and-a-half (Amsterdam) inches and a quarter of an inch thick. Another form obtained from Patabahan was bullet shaped, two inches through, black outside and full of bits of leaves. Kampar in Sumatra produced three kinds of gambir—one flat and round, four inches through, one the size and shape of a flint gun bullet, and one resembling the Siak form, but heavily adulterated. These forms seem to have died out, the fancy of the natives being for *gambir bulat, papan* and *dudur*.

The Chinese also make *Gambir papan, bulat, paku,* and *dudur*; and also bale gambir. This latter is the common form made by the small cultivators, and is usually made up on the field in the form of oblong blocks about eighteen inches long and eight thick. Each block is enclosed is a rush matting. The merchant makes it up into bales for export. It is the wettest of all the gambirs, containing an excessive amount of water, and is a sticky mass, dark brown outside, yellowish within.

Planting.

The greater number of cultivators prefer to grow the gambir on virgin soil, newly cleared of jungle. Some plant on old tapioca ground, or put tapioca into the fresh cleared jungle ground first and plant gambir on it after a year or two. I have seen good results from this, but I have also seen a plantation quite dead after about five years, which had been grown on old tapioca soil even after brushwood had been allowed to cover it between the cultivations. Neglect and excessive cropping may have been the cause of this destruction, but the soil had been a long time under tapioca, and was probably very poor.

Virgin soil is, however, doubtless the best for gambir, but in any case when the land has been under cultivation previously, whether with tapioca or any other crop, it should be fallowed and let to return to jungle for a time before re-planting. Old gambir ground if left soon reverts to secondary jungle if the soil is good and after a few years can be re-planted.

The soil most commonly found in Singapore consists of a yellow clay. Sandy soil is, however, better. In Bangka yellow sand mixed with clay is preferred. In the Rhio-Lingga Archipelago the soil is red loam mixed with sand and covered with a slight layer of humus.

From sea level up to about four or five hundred feet altitude is the proper range of cultivation; above this the plant does not seem to thrive.

In all plantations it is essential to retain belts of jungle close at hand to supply firewood and to act as screens for the crops. To make any crop requiring the use of firewood pay, it is essential to have the firing accessible and plentiful. The difficulty of getting wood close to the gambir and pepper fields in Singapore has led to the abandonment of much of the cultivation. In many parts of Malacca, abandoned land very quickly reverts to brush-wood and eventually jungle, but in Singapore a deserted plantation is immediately overrun with lalang *(Imperata arundinacea)*, a useless grass which entirely prevents the growth of brush-wood for many years and which has to be entirely eradicated with the hoe before any further cultivation can take place. Lalang is easily kept out of the plantation by a belt of jungle, and this is an additional reason for keeping it surrounded by forest.

But indeed it is to be hoped that now the day has gone by when the planter, whether of tea, coffee or gambir, or of any other crop, on a large scale destroys all the forest on his property in order

to get a little more acreage of cultivation. The disastrous results of such a practice are now well known to all intelligent European planters, and we may hope that the experience learnt at such expense in other colonies may not be neglected by planters in countries not yet injured by excessive denudation of forests.

Sowing.

The seeds are very minute and light. The capsules are gathered when they begin to split, and laid on a sheet of paper or cloth till the seeds fall out. The Natives say that they will not keep above twenty-four hours. This is incorrect, with care they can be kept as long as six months, but for this they must be kept in a dry, tin box so as to be free from the attacks of caterpillars, and must be dried in the sun at least once a week, or they will be destroyed by mildew. The duration of the seed much depends, I believe, on its dryness when gathered. However, it is better to sow the seed as soon as possible after it is ripe. In Singapore the Chinese rarely make seed beds or nurseries for the young plants, but sprinkle the seed loosely on any bare patch of ground, often among the pepper-vines, and do not even cover them with soil. They have a superstition that the seed must be sown by a man who never drinks spirituous liquors, or it will never germinate.

The better class of cultivators, however, form nursery beds for the young plants. The beds are made by preference on the low-lying, damp, black soil, by the streams in the valleys, and each bed is surrounded by a trench of water. The seed is carefully sprinkled over the bed and a little soil is in like manner sprinkled over it. The beds are shaded with coco-nut leaves supported on sticks about three feet from the ground. It appears to me, however, that the plants more fully exposed to the sun, viz., those at the edge of the beds, thrive better than the inner ones which were more shaded. It is certain that gambir is a plant which, when fairly developed, wants as much light as it can get.

The seed takes from fourteen days to two months to germinate, or even longer. About half of what is sown comes up.

Cuttings.

In Bangka, according to Dr. Romburgh, the plant is propagated by cuttings only, in this manner, the bush is cut down and burnt, and twigs, not too young, of the old plant are cut into lengths and stuck in the bare ground. If necessary, they can be removed to a different part of the plantation when they have developed into young plants. In the Peninsula and Rhio the plants are never grown from cuttings, and indeed I never found them to strike well.

Seedlings.

The plants when about nine months old and a foot tall are removed from the nurseries and planted out in the future plantation. Small square holes are dug in the ground about 12 feet apart, and the plants put in so that the top leaves are on a level with the top of the hole, and a piece of fern is laid on the top to shade

the little plant. This prevents any damage from a too sudden change from the shaded seed bed to the hot open field. The trees grow very rapidly, sometimes as much as a foot a month, and in a year, or better still a year and-a-half, the first cutting takes place.

The plants are never manured at all, but in some plantations the used leaves are thrown back upon the soil and serve as manure. Manuring properly would probably make a great improvement in the yield, as the strain on the plant from cutting so heavily must be very great.

The soil that seems to suit the plant best is rather sandy and quite dry, with full exposure to the sun. Care must be taken that water cannot accumulate at the roots in any way, which is most injurious to the plant. It is, therefore, usual to select a hillside for the cultivation so that the water may escape as quickly as possible after rain.

The common cultivator takes no pains to keep his plantation free from weeds and grass, and undershrubs are allowed to grow up so as often to quite conceal the bushes. It is only cleared shortly before cutting for convenience of the gatherers. In the better plantations the ground beneath the bushes is kept absolutely clean of weeds. The advantages of this are obvious, but at the same time it must be remembered that in a hot and dry climate the rootlets of the plants are very liable to suffer from sun heat on the soil, if they are not shaded in any way. For this reason it is advisable to plant the seedlings close enough for their branches to touch each other when adult, and so throw shade over the whole ground.

It often happens that other plants get mixed in among the seedlings in the nursery bed, and there is among them especially a Rubiaceous plant (*Chasalia curviflora*), which is very common, and of which seedlings are liable to be mistaken for gambir plants. There is, however, an easy test for the true plant, apart from the taste of the leaf, which is unmistakeable. Take a leaf of the suspected plant and rub it to pulp between the finger and thumb, when if it is gambir a white sticky liquid will presently exude and form a lather.

Enemies.

The plant is remarkably free from the attacks of insects, and other pests. The deer do a small amount of damage by nibbling the young shoots, and it is due to their constantly visiting the fields at dusk and early dawn that the tiger is so frequently seen in or near the gambir plantations and not rarely attacks and kills the coolies at their work at these times.

The only insect I have observed on the plant is the larva of the common Atlas-moth (*Attacus Atlas*), a very destructive insect on account of the amount of foliage it devours. It is rarely found on the gambir, however, and usually seems to have attacked the tree after devouring all the leaves of some other plant upon which the eggs were originally laid, and finding itself then pressed for food.

Cropping.

Although some cultivators take the first crop as early as six months after planting, it is much better to wait for a year and a half before taking the first crop. Many planters crop at the end of the first year without doing any apparent damage to the plant, but the crop taken then is very small, and it is much better to let the plant get to its full strength before cutting.

The small cultivator in Singapore crops three times in two years, but then crops very heavily. The more careful planter takes a smaller crop every four months. As there are practically no seasons in Singapore, the time of the year when the crop is taken is of no importance, so long as it is not taken too soon after the last crop.

In extensive cultivations it is generally so arranged that different portions can be cropped in rotation, by which means a comparatively small boiling plant can be kept regularly at work all the year round, instead of having a press of work at one time and nothing to do at another. For this reason cropping on a small scale every four months is most suitable for large estates.

In the small cultivations pepper is usually cultivated with the gambir, the same apparatus doing for both, partially. In this case the two crops are allowed to alternate, so that while the pepper is growing the gambir is being cropped and boiled.

With ordinary care a plantation will last for from 13 to 20 years, but, as a rule, after 15 years it is nearly worn out. With really careful cultivation it will last from 25 to 30 years. It is at its best in about 8 years after planting.

The ordinary Chinese coolie crops the gambir with a curious little knife, the blade of which is curved and broad, and about three inches long. With the aid of this he breaks rather than cuts off the branches of the plant.

The Malay, on the other hand, plucks the leaves, saying that the Chinese cut the tree to death, but on enquiry I found that under their system the bushes are decidedly less proliferous and live shorter lives. At the same time there can be no question but that the Chinese do in many cases over-cut the plants, and treat them very roughly. This is especially the case in small cultivation where, unless a large quantity is cut, the amount of gambir made is too small to bring a sufficient amount of profit.

It is probable that the cutting of the branches has the advantage over mere plucking of the leaves, in that it keeps down the excessive development of wood, and, in fact, takes the place of pruning. Like all species of the genus *Uncaria* the plant has a tendency to make wood very rapidly at the expense of the leaves, and this requires to be kept back, especially as the twigs produce but little gambir, and are to all intents useless in the production of the drug.

The Chinese on cutting the branches put them into large rattan baskets about three feet tall and carry them to the gambir shed. Here they are thrown into a trough and the bigger sticks removed. The rest—leaves, twigs, flowers and fruit—are all thrown into the boiling pan.

The bushes recover their mutilation with surprising rapidity, and young shoots are put out again very soon.

In cutting it is to be remembered that the old, dark green, firm leaves only produce the drug, the young leaves and buds little or none, at the same time the terminal shoots must be cut at least from time to time to keep the bushes at a convenient height (usually about four feet tall) for gathering. Whether it is preferable to cut the bushes comparatively lightly so that too great a strain is not put upon the plant, by which means the plantation might be made to last in good producing order for a great number of years, or whether to cut heavily (as the Chinese and Malays often do) and work out the trees in six or eight years, and then re-plant, will depend on the circumstances of the planter. Gambir grows so rapidly that it is probable that the latter plan may pay best in many cases.

Manufacture.

The leaves and twigs are brought to the factory, as above stated, in large rattan baskets, each of which contains about four cubic feet. Ten of these baskets will produce about 120 pounds of gambir.

After roughly taking out the larger sticks, the leaves and small twigs are thrown into a large iron cauldron of boiling water.

The cauldron is sunk in the clay floor of the shed, which is so raised as to allow of a large fire being built underneath. It is about five feet across and four feet deep and is filled full of the leaves. There are from two to twelve or more cauldrons in the shed, according to the size of the plantation.

While it boils two coolies are employed in stirring it round with large three-pronged stirrers made out of the hard wood of the Tampinis tree (*Sloetia sideroxylon*). These implements are about six feet or more in length, with a strong handle ending in a club-shaped portion with three prongs arranged in a circle. They are made from a single piece of wood. This stirring is considered the hardest part of the manufacturer, and the coolies employed in it are paid at a higher rate.

The leaves are boiled for some hours till they are quite broken up and yellow. They are then removed with the aid of a large wooden fork and a kind of rattan racket is also used to collect the bits which escape the fork. They are then thrown into a large trough made out of half a tree-trunk scooped out, about 12 feet in length, and cold water is poured on them. The first two washings are allowed to run back into the cauldron and then a small bamboo trough is put to the end of the large one, and the remaining liquid allowed to run off into the next cauldron. This liquid is used to boil the next lot of fresh leaves in. The broken up leaves while being washed are constantly stirred up with the large fork, and when the water runs off clear it is allowed to run into the second cauldron.

The liquid in the cauldron is still boiled for some time longer after the removal of the leaves, till it becomes of a deep brown colour, during which a perforated coco-nut shell attached to a

rattan is suspended in it in which all the remaining bits are caught as the liquid boils. It is then baled out into little tubs about 13 inches tall and a foot or nine inches across and set to cool. Any remains of sticks, leaves &c. are carefully taken out, or, the Chinese say, it will not set. When the cauldron is used for the first time, it is necessary to boil some other leaves in it for some hours, or the gambir will turn out black owing to the formation of tannate of iron. Bamboo leaves are generally used partly on account of their abundance and partly perhaps on account of the silica which they contain scouring the rust off the new pan.

When the liquid is cool, the coolie commences the operation of setting the gambir. This is done with the aid of small cylindrical sticks of wood about an inch and a half thick and 9 inches in length, a little shorter than the diameter of the tub. These sticks are commonly made of Mahang putih (*Macaranga hypoleuca*), but really any stick of the right size will do, and I have seen even joints of bamboo used. Sticks which have been used several times will make the gambir set faster than newly cut ones. The coolie takes a stick in each hand and squats down by two tubs, and commences by giving the liquid a stir or two. Then holding the stick beneath the liquid in a sloping position away from him he passes his hand down it in a spiral direction, rubbing hard against the stick. This operation takes about a quarter of an hour. The liquid, which is at first of a deep brown chocolate colour, becomes gradually lighter and yellower, and almost suddenly becomes as viscid as treacle. It shrinks considerably, about an inch in a pailful, at the same time. When the hand can no longer move easily in the gambir the operation is complete. In a very few minutes the whole has set in to a bright yellow claylike mass. It takes some hours to become solid enough to be taken out of the tub, but eventually a knife is passed round the sides of the tub, and the whole is turned out and allowed to dry.

In the bigger plantations it is put into a large hand-press and squeezed to expel the water. It is then cut into small blocks of 2 or 3 inches cube and put out to dry on a frame of rattan. It is dried partly over a fire and partly in the sun. As it dries the outside of the blocks becomes dark brown, the interior remaining yellow, and it is still quite soft like wet clay. It takes about half a month to dry properly, and is then made up into oblong blocks, wrapped in grass mats (Bale gambir), or left in the cube shape (Cube gambir) and sent to town for export. This is the Chinese method of manufacture of bale and cube gambir in Singapore and the Straits generally. In Bangka the method adopted is different, and will be described below. The Malays adopt the Chinese plan, with some variations in the making up of the stuff, as they manufacture gambir for chewing with betel, and have hardly as yet begun to manufacture for export. In Cuperus' time the method was slightly different. The cauldrons had at the top a continuation in the form of a cask of staves three feet high and luted with clay, so that it was not burnt by the fire. The advantages of this were that a smaller kettle could be used, the liquid is said to boil better in it, besides offering a smaller surface of iron to the liquid gambir, by which a better coloured product was pro-

duced (owing to a smaller formation of tannate of iron). I have seen this arrangement in some boiling sheds. Copper boiling pans would obviate this chemical change to a large extent, as copper is not acted upon by tannic acids.

The liquid was then poured through a sieve into earthern pans and set to cool. When cool enough to put the hand in the planter took a piece of linen in his hand with which he continually stirred the sap, and every now and then wrung the linen in the liquid whereby the sap became speedily thick and stiff. It was then left till quite cold, when it was bundled in a piece of flemish linen and placed under a press to drive out the remaining water. The press consisted of a long beam, one end of which was inserted into a hole in a tree or a post and the other weighted with stones. The gambir was put in the cloth between two boards and the weight of the stones allowed to drop on it so as to squeeze out the water.

This method is not in use now, as far as I know, but the Malays sometimes get the gambir by merely crumbling the liquid as it were in their hands and not using a stick or piece of linen at all.

Bangka Method.

The account of this I take from Dr. Van Romburgh's Report, 1891 (*Korte Berichten uits Lands Plantentuin*). The leaves and twigs are first gathered and exposed to steam for 15 minutes, the mass still hot is put into a basket made of plaited rattan and placed under a wooden press of most simple construction. The liquid is collected in earthenware dishes and exposed to sunheat until it is sufficiently inspissated, when it is removed on to a flat board, with very low sides, of a height equal to the thickness of the cakes. In this wooden tray the gambir is cut up into cakes by means of threads and is left till it is dry enough to be turned over and still further dried in the sun.

Here it will be noted that there is no stirring of the liquid or rubbing it with a stick required. It seems to set of itself.

The Bangka gambir, which was analyzed by Dr. Romburgh, consisted of light yellowish brown flat square pieces that floated on water and only sank after long immersion. In fact it is what is known here as *gambir papan*.

The result on analysis of this product is very different from that given by Mr. Evans from gambir exported from Singapore, but I do not quite understand the figures which in all Dr. Romburgh's calculations work out to above 100.

Water, ...	18.5 %
Catechin, ...	57.0 about.
Catechutannic acid (absorbed by hides), ...	1.6
Matter (organic) insoluble in boiling water, ...	2.5
Matter (organic) insoluble in boiling alcohol, ...	8.5
Matter (inorganic) insoluble in boiling alcohol,	1.8
Ash, ...	2.6
Organic matter other than the above, ...	20.0 about.
Total, ...	112.5

Some of this Bangka gambir was sent by the *Factorij der Nederlandsch Handel Mijners* to some experts (merchants) in Singapore, who reported that the gambir was boiled too young and was mixed with *deduk* (rice dust), quite unsuited for export to Europe and only fit for consumption in Java. Dr. Romburgh thinks that this supposed appearance of *deduk*, of which he declares there was not a trace, was possibly due to the product being richer in catechin which separates in larger crystals, either because the product is pure or has been less agitated on settling.

Adulteration.

A good deal of complaint has risen lately about the inferiority of the gambir exported now, which has been stated to be much adulterated. I cannot find, however, that, excepting in a certain class of chewing gambir, there is any adulteration properly so called. In chewing gambir, made in Negri Sembilan and elsewhere, rice dust called *deduk* is often added, rather, I believe, to give a whitish colour than to increase the bulk.*

It is the excess of water that is most complained of. Mr. W. N. Evans, of Bristol, writes that the ordinary block comes over with 30 to 50 per cent. of water in it. This seems an enormous excess and could certainly be reduced. It was reported to me that it was a common practice of the Chinese town *towkay*, who purchases the gambir from the manufacturer, to open the sacks and pour water upon the gambir pounding it in to increase the weight. To test this, I sent Mr. Evans some gambir which I took out of the manufacturers' shed, and which had not passed through the *towkays'* hands at all. This he analysed and I append the analysis of this and one of gambir after it had passed through Singapore.

	Ordinary block gambir from Singapore.		*Sample from the field.*
Tannin, ...	14.63	...	11.48
Organic matter,	42.26	...	30.11
Water, ...	31.89	...	53.39
Ash, ...	6.34	...	4.46
Loss, ...	4.88	...	.56
	100.00	...	100.00

The organic matter contains catechin and other organic acids not precipitated by gelatine. From this it can be seen that there was absolutely more water in the manufacturer's gambir than in that of the *towkay*, and, therefore, it is probable that this adulteration does not, in the general state of things, take place. Mr. Evans then suggested that I should dry a quantity of the leaves in the shade and export them to England in order that the gam-

* Couperus says that in his time the people of Patabakan mixed a portion of the boiled leaves with the gambir to increase the weight. Those of Kampar (Sumatra) cut the cooked leaves as fine as flour and mixed them in, and the Siak men added sago flour.

bir might be extracted from them, and so the heavy loss due to the excess of water might be avoided. I was not so sanguine as to the results of this experiment as he was, for in the first place, a case of dried leaves is very bulky in proportion to the amount of gambir which could naturally be expected to be derived from them, and in the second place, from the taste of the dried leaves and from what the Chinese told me I was convinced that the drug absolutely disappears on drying, and this indeed proved the case. I found it impossible to dry the leaves in this wet climate in the shade, as they merely decomposed, and so had to use artificial heat, which, however, I kept very low. The leaves on being tested by Mr. Evans did not contain a trace of gambir. As a matter of fact it is essential to treat the leaves as soon after plucking as possible; after twenty-four hours they become brown and worthless.

This being so, it is obvious that the gambir must be manufactured on the field, and the water should be extracted there. There should be no difficulty about this in ordinary circumstances, but as a rule, little trouble appears to be taken with this matter. Very few of the Singapore plantations possess even as simple a press as that described by Couperus, and the gambir is, in fact, not pressed at all.

Mr. Finlayson tells me that the shrinkage of bale gambir is 7½ per cent. by steamer to London. If this shrinkage could be saved a higher price could be paid for gambir here, and certainly it ought to be possible to extract at least this amount of water before shipping it. Some gambir that I have seen which was supposed to be fit for sale in Singapore was so wet that in a day or two it was covered thickly with a dense crop of mildew. This contained nearly 50 per cent. of water.

Chemical Composition.

Fluckiger and Hanbury (*Pharmacographia*, p. 337) state that gambir in composition agrees with cutch (*Acacia catechu*), and especially with the pale variety made in Northern India. Both consist mainly of catechin, and the yellowish colouring matter was determined by Hlasiwetz and Lowe to be quercetin, also occurring in cutch.

The results of quantitative analysis vary to a certain extent according to the method used. In the analysis of Messrs. Evans and Dr. Romburgh the methods employed are not given, so it is difficult to compare these analyses. The latter gives also an analysis of Singapore gambir, cube No. 1 in bags, which may be compared with Mr. Evans' analysis of Singapore gambir:—

Water, ...	...	16.2 per cent.
Ash, ...	...	3.9 „
Catechin, ...	...	42.0 „
Catechu-tannic acid, ...	...	5.9 „
Other organic matter, ...	...	32.0 about.
„ „ insoluble in alcohol,	...	16.1
„ „ „ in water,	...	5.5
		121.6

The water here is much less than in Mr. Evans' two samples. Dr. Romburgh says the water in commercial gambir seems to vary from 9.5 to 16 %, but it is certainly too often more than this. The question of the water I have, however, dealt with.

The ash varies, says Dr. Romburgh, from 2.5 to 5.4 %, and he suggests it is influenced by the amount of water used in contact with the gambir. Thus in Singapore gambir made by boiling the leaves in water (as described above), he found 3.9 ash, while in Bangka gambir made by steaming he got 2.6 ash only. In Mr. Evans' analysis the ash is given as very much more than this, viz., 6.34 and 4.46.

Fluckiger (l. c.) got 2.6 ash from some cube gambir, and this he says consisted mainly of carbonates of calcium and magnesium, but there must be some error in this, as these salts are not stable under heat.

The catechin and catechu-tannic acids are, of course, the important factors in the gambir. In Dr. Romburgh's samples Singapore gambir contained less catechin and more catechu-tannic acid than that of Bangka. This difference, he says, is most likely mainly due to different modes of preparation. According to the Bangka method one would obtain less extractive matter and owing to the much shorter exposure to boiling heat, the amount of catechu-tannic acid produced by decomposition of catechin (which change appears to be produced on protracted boiling) would be less.

Catechu-tannic acid is an anhydride of catechin which can be obtained by gently heating the latter. It is soluble in water and capable of decided tanning properties, precipitating alkaloids and albumen. It must, therefore, be remembered by manufacturers that if a product rich in catechin is required, excessive heating must not be resorted to.

Dr. Romburgh mentions an instance published (but where he does not say) in which a sample consisting of round pressed cakes of 2.5 to 3 grams each, gave catechin only (40 %) and no catechu-tannic acid. This sample was said to have come from China. If so it was probably not gambir at all, as gambir is not made in China.

If a leaf of gambir be rubbed in the hand, as described before, a soapy looking substance is exuded, of a white colour. This put under the microscope can be seen to be composed of innumerable white crystals, very minute, acicular, much resembling those of prepared gambir, only smaller. These are crystals of catechin. They are not visible in the leaf itself, nor can they be obtained by cutting the leaf across and expressing the little juice obtained on a glass slide. From this, I gather that the catechin in the living leaf is in a state of solution, and is crystallized only on friction.

The leaves, which are very rich in chlorophyll, become brown very rapidly when bruised. A transverse section shows that this is not due to the alteration of chlorophyll, but to the alteration, probably oxidation, of the other cell contents, probably the liquid containing the catechin, which becoming brown masks the green chlorophyll.

When the leaf is brown, no catechin remains, so that I gather that the catechin is only stable in the form of crystals, and that the liquid containing the catechin is rapidly destroyed by oxidation.

In conclusion, I may state that the chemical investigation of gambir during the various stages of the growth of the plant and preparation of the extract, has been taken up by Dr. Bott, Government Analyst of the Straits Settlements. We may, therefore, look forward before very long to a paper dealing fully with the chemistry of gambir, the knowledge of which at present must be considered incomplete and in some respects even indefinite.

At present I am able to append the results of analyses by Dr. Bott of a number of samples of gambir, and to add a few general remarks as to gambir considered chemically.

Analyses.

No. 1.—*Malacca Finger Gambir (Gambir paku) No. 1 quality.*		No. 2.—*Malacca Finger Gambir No. 2 quality.*	
Water, ...	14.50	...	13.35
Ash, ...	2.92	...	3.50
Catechin, ...	43.00	...	42.00
Catechu-tannic acid,	3.00	...	5.20
Organic matter other than tanning principles,... ...	36.58	...	35.95
	100.00		100.00

No. 3.—*Malacca Finger Gambir. No. 3 quality.*		No. 4.—*Malacca Flake Gambir (Gambir papan).*	
Water, ...	19.99	...	14.25
Ash, ...	3.65	...	2.80
Catchin, ...	42.20	...	44.00
Catechu-tannic, ...	7.30	...	2.80
Organic matter, ...	26.86	...	36.16
	100.00		100.00

Bale Gambir as received in Singapore.

	No. 5		*No. 6*
Water, ...	36.65	...	44.02
Ash, ...	3.50	...	3.54
Catechin, ...	26.10	...	20.50
Catechu-tannic, ...	9.20	...	11.00
Organic, ...	24.55	...	20.94
	100.00		100.00

From the above it appears that No. 3 is really the richest in tanning principles, though containing more water than the rest, except the very wet bale gambir. The low percentage of tanning principles in bale gambir should be considered, together with the large percentage of water. Referring the percentages of tanning principles to the samples free from water we get the following:—

		Contains total tanning principles.
Dry	No. 1 ...	52.60
„	„ 2 ...	54.60
„	„ 3 ...	61.90
„	„ 4 ...	54.46
„	„ 5 ...	55.50
„	„ 6 ...	53.30

It will be seen that, but for the large amount of water, Nos. 5 and 6 are not bad gambir for tanning purposes, although for dyeing they might not be suitable on account of their bad and uneven colour.

Regarding the two principal constituents of gambir, viz., catechin and catechu-tannic acid, it still remains to be proved that they are identical with the homonym extracted from Catechu (*Acacia Catechu*), even the formulæ of both bodies are not definitely fixed. It has generally been assumed that catechu-tannic acid essentially differs from catechin in being directly absorbable by hides, but from the experiments made both catechin and catechu-tannic acid combine with isinglass, gelatine, etc. The ordinary method of separating catechin and catechu-tannic acid is, therefore, obviously inapplicable, and the same applies *mutatis mutandis* to the usual method of estimating tanning principles (in the case of gambir) by means of permanganate.

Before we can determine the value of gambir for tanning purposes, it has to be settled which of the two constituents—catechin and catechu-tannic acid—is "physiologically active," that is, produces good leather, and which is merely pathological, and we shall then know whether in the manufacture of gambir we should aim at production of much catechin and little catechu-tannic acid or *vice versâ*.

Cultivation for Profit.

Now I will give some observations on the culture of gambir for profit, and again will remark that, with improved methods, a larger output of better material would doubtless result.

The best plantation I have seen was that of a Chinaman, Kee Ann, in Malacca.

The owner cultivated other plants besides gambir, but possessed eight hundred acres of the latter and was opening up more land for the same cultivation. He made a larger profit on pepper and tapioca apparently, and did not care much for the gambir, though he evidently spared no pains to grow and manufacture it well, according to the Chinese method.

I got the following details as to expenditure and profit from him.

The estate, 800 acres, produces 6 pikuls a day, which, taking a year at 350 working days, gives 2,100 pikuls a year. This selling at $5 a pikul gives a sum of $10,500 a year. The expense of

making a pikul including cooly-labour, firing, &c., amounts to $3.75, so that 2,100 pikuls cost $7,875 to turn out. This works out to:—

Sale of gambir, ...	$10,500
Expense of making,	7,875
	$2,625 dollars a year profit.

This does not appear a very high profit, but I believe he was really under-estimating it. For while he was assuring me that this did not pay him sufficiently, he was yet opening up fresh gambir fields.

The gambir he produced was block gambir No. 1 which is priced in Singapore at $6 a pikul. If, therefore, he could get full price, the net profits should be $4,725 a year on an estate of 800 acres.

Kee Ann was, as I have said, using the ordinary rough machinery of the Chinese method. With improved apparatus, such as copper cauldrons instead of iron, a better form of press than an old wooden one which he used for pressing out the water of the drug, and more rapid drying apparatus, he would be able to get a greater out-turn, while manuring the plants and increasing the growth of leaf, by removing the flower heads, except where wanted for seed, would give a greater production of leaf, though adding a little to the expenses.

I then examined some Malays, who were manufacturing gambir at Pangkalan Balak in Malacca, as to their profits. The Malays have only small holdings of about 20 to 30 acres, and manufacture only chewing gambir. They adopt the Chinese method of manufacture, but turn out only the forms described above as *gambir bulat*, *papan*, *paku* and *dudur*. No Chinese are employed on the estates.

Twenty acres of land covered with jungle costs $80 to clear, weeding costs $4 a year, coolies, 20 required at 25 cents a day, cost $150 a year. The annual out-put of gambir is 120 pikuls amounting to $720. The carriage of this amount of gambir to Malacca cost $36 as the plantation was a long way off and the roads not very good for part of the way.

Now to tabulate this:—

Preliminary expenses, clearing ground, etc.,	$ 80
Coolies for second year, ...	2,150
Coolies for third year, ...	150
Weeding for two years, ...	8
Carriage of gambir, ...	70
Expenses, ...	$438
Produce, second year after planting, half-crop,	60 pikuls.
Produce, third year, full crop, ...	120
	180 pikuls.

At $6 a pikul, ...	= $1,080
Expenses of produce, ...	438
Nett Profit, ...	$642

But the profit should be much more than this. In the first place the cooly labour is far too highly paid. In most places coolies can be got for six dollars a month or less. Again, with so small an estate, the coolies could not be employed all the year round, but only at the time when the gambir was being planted and prepared.

The gambir I estimate at $6 a pikul, but the finer class of gambir, which indeed these Malays were turning out, was fetching as much as $8 a pikul.

Lastly, the price of transport was exorbitant. The Malays possess no means of transport themselves and had to hire bullock-carts of the Chinese, and they, of course, put on a very high price for their use.

It is indeed always a difficulty to get any native to tell you how much profit he makes on any business. The Chinaman gives false information partly at least because he has some idea that the enquirer's object is connected with some tax on the produce which may be imposed. The Malay probably has no idea what he makes or loses on the business.

I consider it likely that under careful European management, with improved appliances, a good profit could be made out of gambir. Indeed there are a number of wealthy Chinese in the Straits who have derived a large part at least of their wealth from this source, and there is no reason why Europeans should not do the same. Planting has not as yet been thoroughly established in the Straits Settlements, and the few Europeans who have commenced planting have chiefly devoted themselves to coffee, tea, sugar and coco-nuts. There is, however, a Company in Johor which is cultivating gambir on a large scale under the management of Mr. M. Larken, who has also a large coffee estate in the same district. Gambir has several advantages which these products do not possess. The demand for it is large, and its cultivation area at present very restricted. The climate, in which it thrives is a peculiar one. It requires constant rain, and yet plenty of sun; dry seasons are injurious, and, if prolonged fatal to it. Another advantage it has is that it begins to bring a return in a year and a half after planting, and, if necessary, within six months, though this is not advisable. Furthermore, it requires a comparatively simple plant, and thus the preliminary expenses would be less than those of most other products.

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